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New Materials in Textile Innovation

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Abstract: With the development and successful application of each new material, it will lead to a significant progress in the field of textile product design. In order to solve the shortcomings of traditional materials in textile design, based on the discussion of the relationship between new textile materials, new elastic raw materials PTT and PET, and the selection of new materials and product design, this paper briefly discusses the fabric performance test indicators and new material textile design equipment, and uses PTT two-component filament, PTT cotton, PET viscose blended yarn as raw materials to construct the innovative design scheme of new materials in textiles. The properties of knitted products after repeated stretching were compared through experiments. The experimental data show that the average change rate of the product with composite PTT/PET bicomponent composite yarn as the ground yarn after multiple drawing is only 34% it is obviously lower than nylon and spandex wrapped yarn products. Therefore, it is verified that the new materials proposed in this paper have certain advantages in innovative textile design.

1. Introduction

With the continuous improvement of people's spiritual and material pursuit, more and more people pursue a comfortable and high-quality clothing tea farmer, and the clothes designed with the excellent characteristics of new materials meet the needs of mass consumers.

Nowadays, more and more scholars have done a lot of research on new materials in textile innovative design through various technologies and system tools, and have also made certain research achievements through practical research. Uysal R studied the dynamic effect of dyeing two-component (PET/PTT) filament with three different molecular weight disperse dyes at 100 ℃ (after adding ecological carrier) and high temperature (130 ℃). Before modeling, the bicomponent filament was characterized physically and chemically by SEM, BET and DSC. Different models (pseudo first order, pseudo second order, Elovich, and intraparticle diffusion models) are used to determine acceptable dyeing mechanisms. Then dyeing rate constant, half dyeing time and rising time coefficient were measured and analyzed. The adsorption mechanism in the dyeing process of bicomponent PET/PTT filament with ecological carrier was explained, which provided an experimental basis for future research [1]. PetroChemical believes that PTT/Pet parallel bicomponent filament is a new type of composite fiber, and its excellent elastic elongation can be used in textile products. And the bicomponent filament is made in a certain proportion. In order to design PTT seamless knitted products and develop its prediction algorithm, a platform for size prediction and process design was built. It uses PTT/pet to make seamless knitted fabrics. Through the experiment of seamless knitted products, it proves the formation of "uneven light and shade" of this filament [2]. Soussi M introduced DIY (DIY) materials into the field of textile design and proposed how to promote the relationship between texture and color in the design of complex textured surfaces. A mixed strategy of new material categories combining DIY and digital tools was developed, providing a more sustainable alternative for traditional textile materials. In addition, the proposed method is based on two main aspects: exploring bioplastics and their impact on color design and selection, and analyzing the changes of color surface visual perception in texture, light source location and perspective. The result is the use of near to create complex color combinations and textured surfaces; adjacent and complementary colors and the inherent transparency of bioplastics [3]. Although the existing research on new materials in textile innovative design is very rich, there are still many problems in their practical application.

Due to many problems of traditional materials in textile design, PTT fiber, a new material, is reasonably applied to textile products to improve the elasticity, fatigue resistance, dyeing performance and wearing comfort of products. New materials are used to design and apply textiles from three aspects: raw material selection, knitting process, dyeing and finishing. This paper focuses on the development of new products using PTT filament and PTT/PET two-component composite filament as raw materials. According to the different elastic needs of the products, they are respectively used as ground yarn or veil yarn, and the mechanical properties of PTT/PET composite filament materials are studied. The experimental results verify that PTT/PET two-component composite fiber material has good practicability in the innovative design and application of textiles.

2. Research on Innovative Design of New Materials in Textiles

2.1 New Textile Materials

New textile materials refer to the textile materials of high-tech fibers and fabrics manufactured by high-tech processes and equipment. This high-tech fiber includes synthetic fiber, functional fiber and ecological new fiber [4]. Moreover, the textile fabrics made of new materials also conform to the comfort of human body [5]. At the same time, it also has a high-quality appearance, as well as a textile made of new materials such as formability, rich color and processability [6].

2.2 New Elastic Raw Materials PTT and PET

As a new type of polyester product, PTT polymer has excellent characteristics [7]. In the application of chemical fiber, PTT fiber combines the softener of polyamide fiber, the fluffy feeling of nitrile cotton and the stain resistance of polyester [8]. In addition, the inherent high elasticity of PTT fiber makes the excellent performance of various chemical fibers integrated, and it is one of the most popular new synthetic polymer materials in the world [9].

(1) There are two types of PTT fibers that have potential applications in the seamless knitting field: the first type is PTT polymer elastic filament (PTTDTY filament), namely twisted deformed filament [10]. The second type is PTT/PET side-by-side composite high elastic filament, namely PTT/PET two-component composite filament [11]. The former one has more advantages than the nylon elastic filament commonly used at present, and the latter one has more advantages than the existing raw material - nylon wrapped polyurethane filament [12].

(2) PTT/PET two-component composite yarn is made by spinning PTT and PET in parallel according to specific ratio in specific spinning technology [13]. On the fiber section of this PTT/PET parallel composite wire, two flame retardant polymers, PTT and PET, are combined, because the shrinkage of the two flame retardant polymers is different under the same heat

treatment [14]. Therefore, the fiber produces a three-dimensional spiral with higher wool curl efficiency in the longitudinal direction and is rolled into a flying shape, generating a morphological structure similar to the telephone line, thus forming more strength growth effect than pure PTT fiber [15].

2.3 Relationship between New Materials and Product Design Selection

The relationship between the selection of new materials and products through communication with designers and this paper is shown in Figure 1 [16].

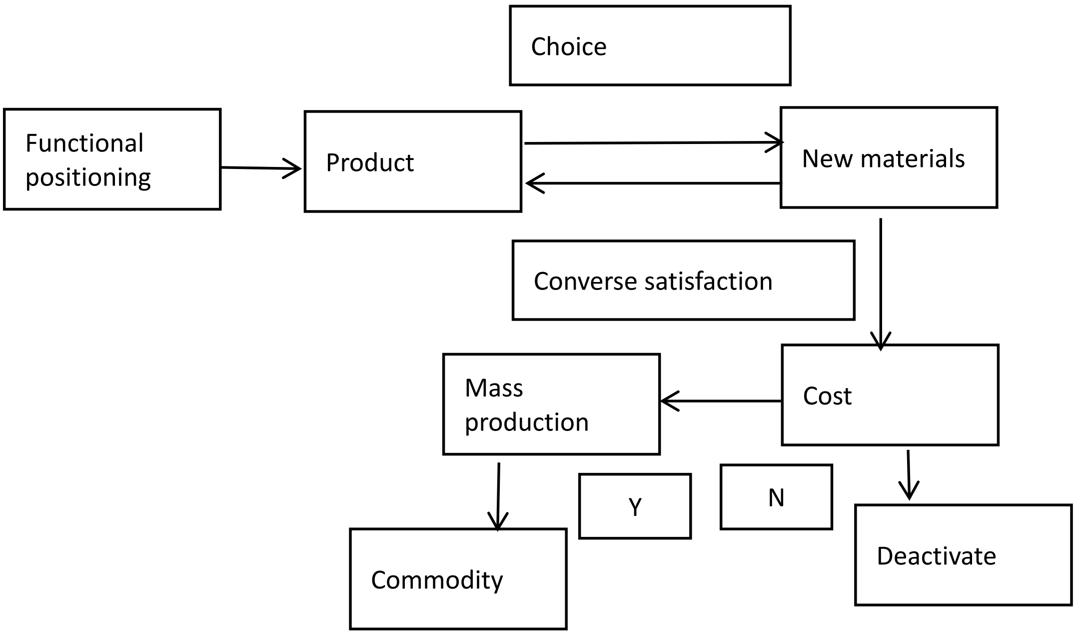

Figure 1: Selection relationship between new materials and product design

2.4 Soybean Protein Fiber

Soybean protein fiber is a new type of fiber material independently developed in China, which has complete independent intellectual property rights. Soybean protein fiber is a kind of fiber which is made of soybean meal as raw material by wet spinning after extracting globular protein from soybean meal by chemical, biochemical and other high-tech methods, and then through a series of chemical treatment, adding functional additives. Soybean protein fiber is a biodegradable fiber. Its production process has no pollution to the environment, so it is a green fiber. The characteristics of soybean protein fiber are: fine monofilament, light specific gravity, high strength and elongation Good acid resistance, good moisture absorption and conductivity, soft feel, soft luster, good warmth retention. With excellent wearing performance, it is called "artificial cashmere". Moreover, the price of soybean protein fiber is much lower than that of silk and cashmere. In addition, after China's entry into WTO, a large number of low-cost soybeans from the United States will flow into China, which is rich in raw materials, providing favorable conditions for us to develop new fabrics.

2.5 Sensory Characteristics of New Materials

The relationship between products and people is also reflected in the world between vision and touch, that is, the world on the surface of materials. More specifically, it is necessary to deal with all surface morphological elements that directly give vision and touch, such as color, luster, pattern, texture, etc. These surface morphological elements will also change due to the change of material surface characteristics and state. Except for the inherent characteristics of a few materials, the color, luster and texture required by the product surface characteristics are mostly obtained by various surface treatment processes.

2.6 Application Fields of PTT Fiber

At present, the main application field is fiber. In addition, it is also widely used in plastics, films, nonwovens and other fields. The composite fiber reinforced with glass fiber by PTT also has strong market vitality. PTT staple fiber can be spun into yarn alone or blended with cotton fiber, Modal, Tencel, soybean fiber, bamboo fiber, wool, cashmere, spun silk or other staple fibers, Production of weft knitted fabrics and clothing. The elastic and non elastic knitted and woven fabrics made of PTT staple fiber yarn have a very wide range of uses in clothing, covering almost all clothing fields. The appearance is elegant, the feel is soft, and the wearing is comfortable. PTT clothing is suitable for men, women, old and young, spring, summer, autumn and winter.

3. Investigation and Research of New Materials in Textile Innovation

3.1 Fabric Performance Test Index

Fabric performance test index

(1) Fabric drapability test

1) Experimental instrument: XDP-1 fabric drape tester.

Sample preparation: cut two samples with a diameter of 220mm, and mark the longitude, latitude and two lines at an angle of 45 with the longitude and latitude on each sample; Cut a positioning hole with a diameter of 5mm at the center of each sample. Static drape coefficient: the percentage of the ratio of the projected area of the fabric sagging part to the original area. The higher the value, the worse the drapability [17].

$$G = \frac{S_G - S_a}{S_A - S_d} \times 100\% \qquad (1)$$

Where, S_A is the fabric area, S_G is the fabric projection area, and S_a is the fabric tray area.

(2) Tensile recovery of fabric

1) Experimental instrument: HD026N electronic fabric strength tester.

2) Experiment principle: firstly, apply 0.2N pre tension to the sample and measure the original length Lo of the fabric, then stretch the sample to 30% elongation and measure the length Lo of the sample at this time, stop for 2min, return to the starting point at the original speed, and then stop for 5min, then apply 0.2N pre tension to the sample and measure the length of the sample, and finally calculate the tensile elastic recovery rate:

$$D = \frac{R_{01} - R_0^{'}}{R_{01} - R_0} \qquad (2)$$

Where, D is the tensile elastic recovery rate, R_0 is the original length mm after tension, and $R_0^{'}$ is the length mm after tension plus pre tension. R_{01} is the total length after stretching mm [18].

3.2 New Material Textile Design Equipment

(1) Model: SANTONI SM8-TOP2 (single plain electronic jacquard).
(2) Machine No.: 28 needles/25.4mm
(3) Barrel diameter: 15 inches
(4) Number of routes: 10 routes. Each route - only 14 grade needle selector, 3 of 10 yarn guide nozzles (among them) are used for colored yarn).
(5) Needle selection hexagon: pneumatically control the needle starting hexagon, the circle setting hexagon and the needle selection of six work positions.
(6) Round hexagonal: independently controlled by motor, each circuit can rapidly change density in the same line.
(7) Automatic control: 4MB memory Dimema motherboard. The program can be directly transmitted from the computer to the machine through FDU-2 disk reader or signal line.
(8) Automatic control: 4MB memory Dimema motherboard. The program can be directly transmitted from the computer to the machine through FDU-2 disk reader or signal line.
(9) Application: It is applicable to the production of underwear, outerwear, swimwear, sportswear and health care fabrics (which can be woven into a terry as required), and provides single fabric separation.

4. Research on Innovative Application of New Materials in Textiles

4.1 Innovative Design Scheme of New Materials in Textiles

(1) Raw materials: (1) In this paper, PTT two-component filament and PTT cotton PET viscose blended yarn are used as raw materials for fabric weaving. The function and form of the product must be maintained by specific materials. In this way, we can establish the relationship among people, products and new materials as shown in Figure 2 below:

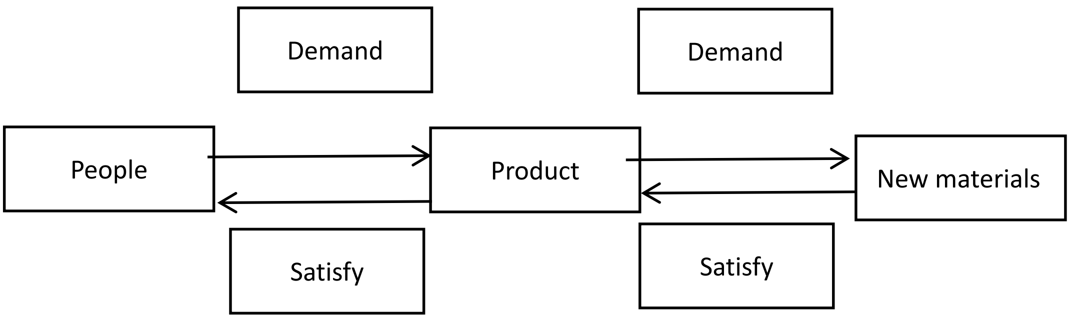

Figure 2: Relationship among people, products and new materials

(2) Clean washing: After the grey cloth is off the machine, it should be boiled in warm water or neutral bath to remove impurities such as textile oil ，=。 It is convenient for the next process to dye evenly, and it is washed with hot water and then with clean water once.
(3) Weaving process: single bead weave is selected for weaving. Nine woven fabrics are required. In the knitting process, according to the measured data in the actual knitting process, the tension range of high tension is controlled at 9-9.5cN, the tension is controlled at 5.5-6cN, and the low tension is controlled at 2.2-2.4cN.
(4) Dyeing and finishing
1) Fabric pretreatment: in order to ensure the dyeing quality, make the fabric plump and dimensional stability, and improve the quality of finished products. The main processes include

refining, relaxation, bleaching, drying, shaping, etc.

2) Dyeing process: Dye two different fibers separately, that is, use the two bath method to dye disperse dyes first, and then dye reactive dyes after cooling and drying. For the process of dyeing PTT fiber with disperse dyes, calculate the amount of disperse dyes and dispersants required according to the bath ratio of 1:30. Add drugs at room temperature, raise the temperature to 50 ℃ at the rate of 2 ℃/min, then put the pretreated sample into the dyeing machine, raise the temperature to 110 ℃ at 2 ℃/min, keep it for 60 min, take out the sample, wash it with 1g/L sodium carbonate solution at 70 ℃ for 40min, fix the color, and treat it with 3g/L sodium hydroxide and 3g/L sodium hydrosulfite solution at 70 ℃ for 40min for color removal. Finally, wash it with cold water and dry it. For reactive dye process, according to the formula, calculate the amount of drugs required according to the bath ratio 1:30. At room temperature, use the most added dye solution according to the calculated drugs. Raise the temperature to 50 ℃ at the rate of 2 ℃/min, put the sample dyed with disperse dyes into the dyeing machine, then raise the temperature to 110 ℃ at 2 ℃/min, keep it for 60 min, take out the sample, wash it in hot water at 80 ℃ with 0.5g/L sodium carbonate solution for 30 min, fix the color, and finally wash it in cold water.

3) The specific dyeing steps are as follows: dye (dye+glacial acetic acid) quality=3% of fabric quality, PH=5~6 can be roughly measured with test paper → heat up to 50°C, △ t=5 ℃/min, stay for 2min, put in fabric → continue to heat up to 125°C, △ t=1.0 ℃/min, keep warm for 1h → wait for the temperature to be lower than 95 ℃ before opening the air valve to depressurize to zero, open the cover and discharge the liquid → alkali neutralization (Na_2CO_3 5g/L, 30min), wash off the floating color with warm water → water cleaning.

4) Flexible finishing: This method uses chemical finishing technology that is, adding softener in the fabric to reduce the friction between fiber and yarn to achieve soft and smooth hand feeling. This finishing technology is often used in production with remarkable finishing effect.

Heat setting finishing: PTT is a thermoplastic fiber, which is used to heat the fabric under a certain tension to fix it in a new state. In this paper, the Rapid heat setting machine is used, which does not stretch longitudinally, but stretches transversely by 13%, and the setting time is 50s.

4.2. Performance Comparison of Knitted Products after Repeated Stretching

It is also classified according to the ground yarn with elastic effect. The performance of new material PTT/PET two-component composite filament (composite filament for short in the figure) and nylon/spandex wrapped yarn products after multiple drawing is compared. The comparison index is the difference between the front and back changes of elongation change rate of the product after six drawing actions. Each drawing action is performed under low load, with the maximum tensile force of 2N/cm. The comparison results are shown in Figure 4 and Table 1 below. The veils are: 1. cotton staple yarn; 2. Polyester/nylon filament; 3-PTT DTY filament. Longitudinal elastic analysis The experimental results of the design longitudinal recovery rate and deformation rate of the material are listed in Figure 3. The serial numbers in the table represent different samples.

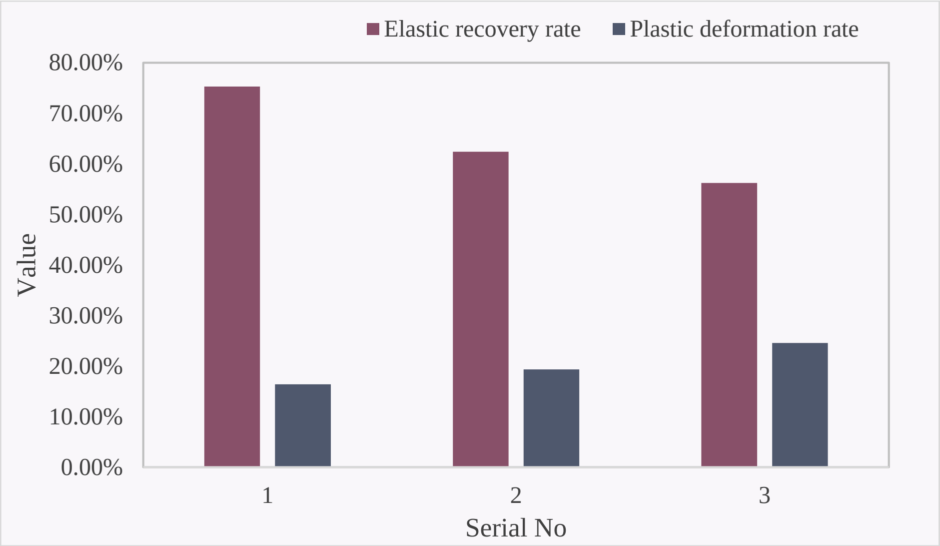

Figure 3: Results of longitudinal recovery rate and plastic deformation rate

From the experimental results of the longitudinal recovery rate and shaping change rate of the new material in Figure 3, it can be seen that the longitudinal recovery rate and shaping change rate of cotton staple yarn are 75.3% and 16.39%; The recovery rate and change rate of polyester/nylon filament are 62.41% and 19.36% respectively; The recovery rate and change rate of PTT DTY filament are 56.23% and 24.57%.

Table 1: Comparison of elongation change rate of yarns from different places after multiple drawing

Type	Composite floor yarn	Wrapped floor yarn
1	31%	42%
2	43%	68%
3	29%	71%

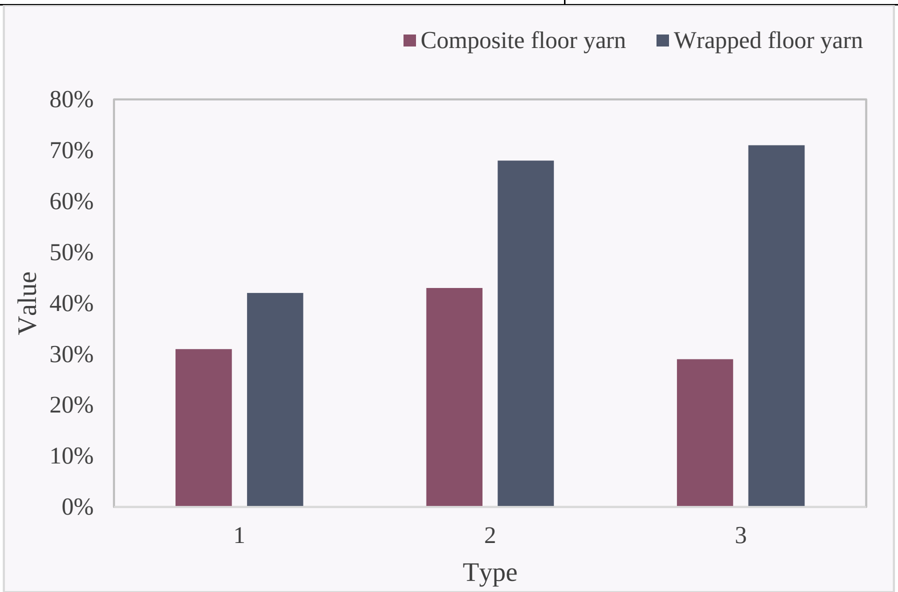

Figure 4: Comparison of elongation change rate of yarns from different places after multiple stretching

The above figure 4 shows the elongation difference of seamless products before and after five times of stretching. It can be seen from the figure that, for various kinds of veils, the products with compound PTT/PET two-component composite yarn as the floor yarn, after repeated stretching, the change of elongation before and after is less than that of the wrapped yarn products, which indicates that the natural crimp structure formed by the different shrinkage of PTT and PET parts is very stable during the fiber processing, and can be well recovered after repeated stretching, Therefore, it has higher multiple tensile resistance than spandex seamless knitted products.

5. Conclusions

Starting from the relationship between new materials and product design and selection, based on the change of traditional materials and process research, this paper combines the technicality of new elastic materials PTT and PET with process and textile product design, pays attention to practical application research, provides some support for the application of new materials and processes, and focuses on the design of textile products using PTT two-component filament, PTT cotton and PET viscose blended yarn as raw materials, A complete set of product design scheme integrating new materials was realized. Finally, through the performance comparison of knitted products after multiple drawing, it was verified that the PTT/PET bicomponent composite filament proposed in this paper had higher multiple drawing resistance in the design and application of textile products. It can play a certain role in promoting the development of design materials science along the direction of textile product design.

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